

TERRESTRIAL PLANARIANS AND NEMERTEANS OF THE OTWAY REGION

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ABSTRACT: Terrestrial planarians and nemerteans are cryptozoic animals found in microhabitats of forests, plantations and agricultural land of the Otway Region. Their distribution is primarily restricted in the terrestrial environment by the availability of moisture.

The ecological distribution of terrestrial planarians and nemerteans within Victoria is best explained in terms of moisture availability. There is a tentative correlation between the occurrence of these taxa and zoogeographic regions of Victoria which can be recognised as distinctly moist.

Of the thirty species of terrestrial planarians that occur in Victoria, eleven have been recorded from the Otway Region. The only terrestrial nemertean species known from Victoria is also recorded from the Otway Region.

Two Victorian zoogeographic regions were recognised in the study area: Cool Temperate Bassian and Warm Temperate Bassian. Taxa considered characteristic of the Cool Temperate Bassian predominate, with elements typical of Warm Temperate Bassian impinging on the north-eastern end of the study area. The terrestrial planarian and nemertean faunas of the Otway Region most closely resemble those of the Macedon Range in Victoria, but differ from the faunas of wet forest to the east of Melbourne mainly through the absence of common Eastern Highland wet forest species. Inadequacies in taxonomic data permit discussion of the affinities and origins of the terrestrial planarian and nemertean faunas of the Otway Region only in terms of the distribution and ecology of these taxa.

INTRODUCTION

Terrestrial planarians (Phylum Platyhelminthes) and terrestrial nemerteans (Phylum Nemertea) are two common and characteristic invertebrate groups of the Cryptozoa. Dendy (1895) defines Cryptozoa as 'the assemblage of small terrestrial animals found dwelling in darkness beneath stones, rotten logs, and the bark of trees, and in other similar situations.'

This paper is part of a continuing investigation into the taxonomy, ecology and distribution of the terrestrial planarians of Australasia undertaken by the author. Previous work on Australian terrestrial planarians was largely confined to descriptions of new taxa, most of which were recorded from only a few localities in each state. Data on the terrestrial nemerteans of this region are also included in this paper because of the close phylogenetic relationships between nemerteans and planarians, and also to augment the recent review of the group by Moore (1975).

The Otway Region is defined as that area south of a line passing through Warrnambool, Naringal, Ecklin South, 4 km north of Timboon, Elingamite, Tandarook, Purumbete South, Stoneyford, Colac,

Birregurra, Modewarre and Breamlea. Distribution surveys for terrestrial planarians and nemerteans within the Otway Region are incomplete and confined to wet forest, conifer plantations and adjacent farmlands within the Otway Ranges. The south-west of the region, near Warrnambool, was not surveyed.

ECOLOGY

Of the five categories of animals inhabiting the cryptozoic niche recognised by Cole (1946) terrestrial planarians and nemerteans can be placed with those forms regarded as transitional between aquatic and terrestrial habitats. They are primarily restricted in the terrestrial environment by the availability of moisture. The majority of species possess no water-saving adaptations and depend upon the micro-environment for their moisture requirements. However, they are sensitive to liquid water and ecologically can be regarded as stenohygric hygrococles (Froehlich 1955b).

Typical microhabitats of terrestrial planarians include soil cracks and fallen fence posts in cleared agricultural land, or leaf litter, stones, rotten logs,

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treebark and leaf bases of some densely foliated plants in forests areas. Under adverse conditions, some species burrow deep into the soil where they ensheath themselves with mucus secretion. The physical conditions that exist in these microhabitats and the way in which they affect the behaviour of planarians are at present ill defined and poorly understood.

Except in overcast or waterlogged conditions, terrestrial planarians remain hidden by day and emerge only at night to feed, when the relative humidity of the air is high, and, in dry areas, they congregate on the mud bordering any surface moisture. They are carnivores and feed upon a wide variety of animals occupying the cryptozoic niche. Some species are cannibalistic and others necrophagic.

Terrestrial nemerteans have similar ecological requirements to terrestrial planarians, but many habitats which support planarians are apparently unsuitable for nemerteans (Moore 1975).

DISTRIBUTION

Low mobility and stenotopy of terrestrial planarians and nemerteans account for fairly stable distribution patterns with a high degree of species endemism. Minor changes in species distribution appear to have resulted from the activities of man in Australia. Anthropochore dispersal in soil and on vegetation and other carriers seems the most likely explanation for some species that occur in both urban and rural areas. These are always associated with man and are often far from natural populations of the same species, ('man-followers' or adventives).

The distribution of natural populations of terrestrial planarians and nemerteans within Victoria cannot be adequately explained solely in terms of single environmental factors such as vegetation, rainfall, temperature and altitude, or by habitat type preferences.

Variations in these combined environmental factors permits the recognition of climatic regions within Victoria. Terrestrial planarians and nemerteans are primarily restricted in the environment by the availability of moisture and their distribution may best be explained in terms of moisture regions.

Davidson (1954) defined Bioclimatic Zones for Australia based upon the monthly ratio of rainfall to evaporation, and Gentilli (1972) related moisture to effective plant growth in Climatic Moisture Regions. These zones and regions do not correspond adequately to planarian distributions. Rawlinson (1969) defined Thermal Zones of the Bassian zoogeographical subregion within Victoria based on reptile distribution patterns. There is a tentative correlation between these thermal zones and the distribution of terrestrial plana-

rian and nemertean species in Victoria. A summary of these zones defined by Rawlinson (1971) follows:

The Bassian area in Victoria includes the Eastern Highlands, South Gippsland Highlands and the Otway Ranges, as well as the western coastal and volcanic plains and the East and West Gippsland coastal plains. The topography and vegetation vary greatly within the Bassian, and rainfall is spread more or less evenly throughout the year. Temperatures of the Bassian are the coldest of the four Australian zoogeographic sub-regions, reflecting the high latitudes and altitudes of the area.

The Warm Temperate Zone includes the coastal plains of south-eastern Victoria, the volcanic and coastal plains of south-western Victoria, the inland margins of the Eastern Highlands and the Kilmore Gap. The low moisture availability in this zone is due to an annual rainfall of less than 800 mm and high surface temperatures resulting from the low altitudes of the area (less than 300 m). The open nature of the vegetation permits intense solar radiation to reach the ground and consequently affords little protection of microhabitat.

The Cool Temperate Zone covers the Eastern Highlands below 1200 m and includes the Macedon and Otway Ranges, and the South Gippsland Highlands. The high moisture availability in this zone is due to high average rainfalls (over 800 mm) and low surface temperatures due to the high elevations. Dense climatic vegetation allows little solar radiation to reach the ground and buffers the microhabitat against the high summer temperatures encountered in warm temperate zones.

The Cold Temperate Zone includes alpine and sub-alpine areas above 1200 m altitude in the Eastern Highlands. Average rainfalls of over 1400 mm and low environmental temperatures due to the high elevation result in microhabitats possessing high moisture availability. Dense forests occur in the lower altitudes but are limited by the severity of the cold to near 1300 m. At altitudes above this, vegetation changes to that of open alpine woodlands, herbfields, swamps and grasslands. At these altitudes, suitable microhabitat for terrestrial planarians and nemerteans is scarce and mostly limited to the open alpine woodlands. This situation is analogous to that observed in the warm temperate zone. Microhabitats in these cold temperate zones are subjected to snow in winter and intense solar radiation during the summer periods.

The Bassian Thermal Zones and the Eyrean subregion comprise the zoogeographic regions of Victoria (Rawlinson 1971). The distribution of terrestrial planarians and nemerteans in Victoria are best expressed in

terms of these regions and extensive distribution studies in Victoria indicate that each of these regions may have a characteristic terrestrial planarian fauna (Winsor unpublished).

Terrestrial planarians and nemerteans in the Australian Region are largely confined to the Torresian, Bassian and South Western zoogeographic sub-regions of Spencer, as modified by Serventy and Whittell (1951). There is insufficient distributional data available for other states to permit the recognition of characteristic terrestrial planarian and nemertean faunas for these sub-regions.

TAXONOMY

The taxonomy of Australian terrestrial planarians is primarily based upon the anatomy of the reproductive organs. All species recorded from the Otway Region belong to the family Geoplanidae, the Australian genera of which are *Geoplana* and *Artioposthia*. Graff (1899) defined two groups within the genus *Geoplana* according to the position of the testes: those species with dorsal testes, exclusively Neotropical and those with ventral testes, chiefly Oriental and Australasian. Froehlich (1955a) restricted the genus *Geoplana* to species with dorsal testes and either the Type 'a' musculature of Graff (very strong superepidermal bundles, absent parenchymal bundles), or at least close to it. He suggested that the genus *Coenoplana* Moseley 1877, originally proposed for Australian species but at present unoccupied, might be emended for those species with ventral testes which can no longer remain in the genus *Geoplana*. An examination of Moseley's original specimens and the emendation of *Coenoplana* is at present under consideration.

Taxa from the Otway Region have been referred to the genus *Geoplana* Fr. Mueller *sensu lato* pending their revision.

The anatomy and distribution of Australian terrestrial nemerteans has been reviewed by Moore (1975); their classification, as used in this paper is given by Gibson (1972).

Data for the faunas are presented under the following headings:

1. *Specimens examined*: This includes specimens in the author's collection (Ge), the National Museum of Victoria (NMV) or the Australian Museum (AM), that were collected within the Otway Region.
2. *Specimens observed*: This refers to specimens observed but not collected and specimens that decomposed following their collection in the Otway Region.
3. *Literature records*: Reliable literature records of taxa recorded in the Otway Region.

4. *Ecology*: Notes on general habitat, feeding, reproductive state, associations and status. Most of these data come from the author's unpublished information, based on Australia-wide observations. Nomenclature of vegetation is after Sprecht (1970).
5. *Distribution*: Records of the species within Australasia and the distribution within zoogeographic regions of Victoria. Terrestrial planarian and nemertean distributions are surveyed and recorded on the Degree by Degree and a half (DDHG) biological grid, used for marine molluscs by Smith and Long (1970) and for Anuran Amphibians by Brook (1975). Most of these distributional data are based on extensive collections made by the author in Australian states. These are supplemented by data obtained from the collections of the National Museum of Victoria, the Australian Museum Sydney, and specimens collected by the acknowledged naturalist groups. The taxonomy and distribution of the Australasian terrestrial planarians will be published elsewhere. All identifications were made by the author with reference to type and other named material.

PLATYHELMINTHES

TRICLADIDA, TERRICOLA

GEOPLANIDAE

Geoplana Fr. Mueller 1857

Geoplana hoggii Dendy, 1891

SPECIMENS EXAMINED: Ge 99, 5 km NW. Benwerrin, six specimens and one cocoon; Ge 313 Aireys Inlet, three mature specimens.

SPECIMENS OBSERVED: Nil.

LITERATURE RECORDS: Nil.

ECOLOGY: This large, yellow-striped species is found mainly beneath rotting logs in Tall Open and Open Forests, often in relatively dry situations such as slopes. Sexually mature specimens have frequently been found from January to March, with juveniles emerging from cocoons in late March; specimens collected in April were immature. In the Otway Region *G. hoggii* was found in association with *G. howitti*; elsewhere it was associated with *G. mediolineata*, *G. m' mahoni*, *G. munda* and *G. sanguinea*. This species differs from the lowlands form of *G. sulphurea* by the presence of paired median green stripes. *G. hoggii* is a common species.

DISTRIBUTION: This species is endemic to Victoria and extends east from the Blackwood Ranges to Mt. Baw Baw, and south to the Otway Region which is the most westerly occurrence of the species. *G. hoggii* occurs predominantly in the Cool Temperate Bassian and less commonly in the Warm Temperate Bassian of south central Victoria.

Geoplana howitti Dendy, 1891.

SPECIMENS EXAMINED: Ge 132, 200, 5 km NW. Benwerrin, two mature specimens; Ge 230, 7 km SW. Benwerrin on Mt. Sabine road, single mature specimen with cocoon; Ge 321,

near falls, Cumberland River in Lorne Forest Park, single immature specimens.

SPECIMENS OBSERVED: Nil.

LITERATURE RECORDS: Nil.

ECOLOGY: Abundant in the microhabitat of the Alpine complex and Tall Open Forest in which the species was first recorded. Also found in lesser numbers in dry Coast complex in Gippsland, Open forest, conifer plantations and rarely on cleared land. It is a medium sized yellow and brown striped planarian, capable of rapid movement, and has been observed to prey upon other planarian species, particularly *G. sanguinea*.

Sexually mature specimens were obtained during January, February, July and October, and cocoons in March; immature specimens were collected in November. The genitalia of this species possess adenodaetyli, characteristic of *Artioposthia* to which *G. howitti* may be referred on revision of the Australasian Geoplanidae.

This species has been found in association with *G. hoggii*, in the Otway Region; elsewhere with *G. dendyi*, *G. lucasi*, *G. mediolineata*, *G. spenceri*, *G. sulphurea*, *G. varigata*, *G. walhallae* and *Geonemertes australiensis*. It is synonymous with *G. robusta* Steel and may be synonymous with *G. warragulensis* Graff and *Artioposthia harrisoni* Wood. Its status is common in the sub-alpine regions, uncommon elsewhere.

DISTRIBUTION: Otway Region, Eastern Highlands, Cape Lip-trap, Wilsons Promontory Victoria and Bundanoon, New South Wales. Its occurrence in the Otway Region is the most westerly record for this species.

G. howitti occurs mainly in the Cool and Temperate Bassian with marginal extension into the Warm Temperate Bassian in north-eastern Victoria.

Geoplana mediolineata Dendy, 1891

SPECIMENS EXAMINED: Gc 133, Anglesea, single immature specimen; Gc 314, 6.5 km NE. Anglesea, single immature specimen; NMV, Apollo Bay, multiple specimens.

SPECIMENS OBSERVED: Boundary road, 9.5 km S. Anglesea.

LITERATURE RECORDS: Nil.

ECOLOGY: This medium sized yellow planarian is common in the microhabitat of Open Forest, less common in Tall Open Forest, Coastal complex, and cleared agricultural land.

Mature specimens have been recorded in November and April, immature specimens in March.

G. mediolineata was not found associated with any other species of planarian in the Otway Region; associations observed elsewhere are *G. adae*, *G. dubia*, *G. hoggii*, *G. munda*, *G. quinquelineata*, *G. sanguinea* and *G. sugdeni*.

There is great variation in the dorsal stripe pattern of this species which may vary from one to five stripes, making it difficult to distinguish from similarly striped species *G. m'mahoni* and *G. quinquelineata*. *G. mediolineata* is a common species.

DISTRIBUTION: Otway Region, Mt. Ararat, Macedon Range in Victoria, and near Adelaide, South Australia. This species occurs mainly in the Cool Temperate Bassian with some marginal extension into the Warm Temperate Bassian of mid-western Victoria.

Geoplana m'mahoni Dendy, 1891

SPECIMENS EXAMINED: Gc 201, 1.5 km S. Benwerrin, single immature specimen; NMV, 3 km S. Lavers Hill, single specimen.

SPECIMENS OBSERVED: Nil.

LITERATURE RECORDS: Nil.

ECOLOGY: A long slender bright yellow planarian found in Tall Open Forest, Open Forest and agricultural land. Specimens collected in March and May were immature. In the Otway Region, *G. m'mahoni* was associated with *Peripatoides*; elsewhere with *G. hoggii* and *G. munda*. It is an uncommon species, but can be distinguished from similarly striped species by its greater length.

DISTRIBUTION: This species is endemic to Victoria and found in the Otway Ranges and Eastern Highlands. A similar but as yet unidentified species has been found near Portland and Koroit, Victoria. *G. m'mahoni* occurs predominantly in the Cool Temperate Bassian in the ranges east of Melbourne.

Geoplana munda Fletcher and Hamilton, 1888

SPECIMENS EXAMINED: Gc 141, Bellbrae, Torquay, two mature specimens; NMV Apollo Bay, multiple specimens.

SPECIMENS OBSERVED: Near Stoneyford.

LITERATURE RECORDS: Otway forest, Dendy (1891, 1892).

ECOLOGY: This small brown and cream species is a natural inhabitant of basalt plains and is also a 'man follower'. It occurs as an adventive confined to agricultural land and urban gardens, naturally along stream banks on basaltic plains. Its natural microhabitat is usually in muderacks or beneath earth clods. It emerges at dusk and feeds on earthworms and carrion stranded on muddy banks. The species has been frequently found feeding in large aggregations similar to the feeding behaviour seen in certain fresh water planarians (Winsor, unpublished). *G. munda* has an unusually high liquid water tolerance for a terrestrial planarian and is often found in waterlogged conditions. Ecologically it may be best regarded as a euryhygic species.

Sexually mature specimens have been recorded in March and April, cocoons in early May and juveniles in May and October. Immature specimens were recorded in June, October, November and December.

G. munda was associated with *G. quinquelineata* and *G. sugdeni* in the Otway Region; elsewhere with *G. atrata*, *G. ventrolineata* and *Rhynchodemus simulans* Winsor (1973a). *G. hoggii*, *G. mediolineata* and *G. sanguinea*. Its status is very common.

DISTRIBUTION: The Victorian distribution of this species is predominantly central and south-west. It also occurs in New South Wales, SE. South Australia and in Tasmania where it is associated with man. Apart from isolated records on agricultural land in Cool Temperate Bassian, *G. munda* is confined to the Warm Temperate Bassian regions.

Geoplana quadrangulata Dendy, 1891

SPECIMENS EXAMINED: Gc 44, Love Creek near Kawarren, single immature specimen.

SPECIMENS OBSERVED: Nil.

LITERATURE RECORDS: Nil.

ECOLOGY: This small brown mottled species was first re-

corded in Tall Open Forest and on stream and dam banks within agricultural land. Immature specimens were recorded in November, mature specimens in December. Little is known of this uncommon to rare species recorded from only four localities all west of Melbourne. It has not been associated with any other planarian species.

DISTRIBUTION: This species is endemic to Victoria and has been recorded from the Otway Region, Macedon Ranges and near Creswick in Victoria. It occurs only in the Cool Temperate Bassian region, and its occurrence in the Otway Region is the most westerly record for the species.

***Geoplana quinquelineata* Fletcher and Hamilton, 1888**

SPECIMENS EXAMINED: Ge 131, 12 km NE. Deans Marsh, single mature specimen; Ge 142, Bellbrae, Torquay, multiple mature specimens with cocoon; Ge 144 Gnarwarre, single mature specimen.

SPECIMENS OBSERVED: Nil.

LITERATURE RECORDS: Otway Forest, Dendy (1891, 1892).

ECOLOGY: This medium sized yellow and brown striped species is found in Open Forest and agricultural land. It is a 'man-follower' and occurs on agricultural land in cool areas. This is the only terrestrial planarian as yet found in Grassy Open Scrub (Mallee).

Sexually mature specimens were recorded in January and March, juveniles early April, and immature specimens in October and November. It has been associated with *G. munda* and *G. sugdeni* in the Otway region; elsewhere with *G. hoggii*, *G. mediolineata*, *G. munda* and *G. sanguinea*. Of these species, *G. munda* is the most common associate of *G. quinquelineata*. This is a very common species.

DISTRIBUTION: Eastern New South Wales, Northern Tasmania, South Australia, South Western Australia and introduced into New Zealand.

In Victoria the distribution of this species is almost exclusively Warm Temperate Bassian with marginal extension into the Eyrean sub-region in the Bealiba and Little Desert areas of Victoria, and near Kingston, South Australia. The few isolated records of this species in Cool Temperate Bassian areas in Victoria and Tasmania were always associated with agricultural land.

***Geoplana sanguinea* (Moseley *sensu* Fyfe 1948)**

SPECIMENS EXAMINED: Ge 202, on the bank of Charley's Creek, 1.5 km S. Gellibrand, single mature specimen; NMV G 747, 748, Apollo Bay.

SPECIMENS OBSERVED: Cumberland River near falls, upstream from camping ground; 7 km SW. Benwerrin on Mt. Sabine road.

LITERATURE RECORDS: Nil.

ECOLOGY: This white to red coloured species is found over a wide range of habitat from Alpine complex to Tussock grassland. It is a 'man-follower' and is commonly encountered in urban gardens. Sexually mature specimens have been recorded for each month of the year, and juveniles in early April. The species is not gregarious and usually only single specimens are found. It has, however, been associated with nearly every known species of terrestrial planarian found in Victoria. It is a common form.

DISTRIBUTION: This species has the widest distribution of any Australian terrestrial planarian, extending from north of Ingham, Queensland, New South Wales, Victoria and Tasmania and South Australia. It has been introduced into New Zealand. In Victoria, *G. sanguinea* is widespread throughout the Bassian subregion, with the only record in the Eyrean associated with man in Mildura. It is rare in South Australia and this may be the limit of its westerly distribution.

***Geoplana sugdeni* Dendy, 1891**

SPECIMENS EXAMINED: Ge 159, Bellbrae, Torquay, single mature specimen, AM, W1541, Forrest.

SPECIMENS OBSERVED: State school grounds, Barramunga, Pirron Yallock Creek near Swan Marsh.

LITERATURE RECORDS: Nil.

ECOLOGY: A medium sized yellow planarian, *G. sugdeni* frequents Open Forest and agricultural land mainly in coastal regions. It is one of the few terrestrial planarians found crawling about in daylight. Sexually mature specimens have been recorded in late November. This species was associated with *G. munda* and *G. quinquelineata* in the Otway Region; elsewhere with *G. hoggii* and *G. munda*. This is a common species in coastal areas.

DISTRIBUTION: Mainly southern coastal areas of Victoria and northern coastal areas of Tasmania. In Victoria this species occurs in both the Warm and Cool Temperate Bassian.

***Geoplana sulphurea* Fletcher and Hamilton, 1888**

SPECIMENS EXAMINED: Nil.

SPECIMENS OBSERVED: Nil.

LITERATURE RECORDS: Otway Forest, Dendy (1892).

ECOLOGY: Two forms of this species exist, a lowland form which closely resembles *G. hoggii* and an alpine form, smaller and with a more pronounced dorsal stripe pattern. Sexually mature specimens of the lowland form have been recorded in January, October and November. The associations of this species are similar to *G. hoggii* with which the lowland form is probably synonymous.

DISTRIBUTION: The lowland form occurs in the Otway Region and central Victoria, Mt. Wilson and Hartley Vale, New South Wales and introduced into New Zealand. In Victoria this form occurs in both the Warm and Cool Temperate Bassian.

***Geoplana* sp.**

SPECIMENS EXAMINED: Ge 232, Benwerrin.

SPECIMENS OBSERVED: State school grounds, Barramunga; 7 km S. Benwerrin on Mt. Sabine road; camping area Cumberland River, Lorne Forest Park.

LITERATURE RECORDS: Nil.

ECOLOGY: This medium sized yellow planarian with three ill defined green dorsal stripes was found in wet conditions under logs in Tall Open Forest, near a farm dam and in a camping ground. Specimens collected in May and November were sexually mature, and were associated with *G. howitti*, *G. sanguinea* and *G. sugdeni*. The species is uncommon, and unlike any other species in this Region.

DISTRIBUTION: Otway Region, Cape Liptrap, Stony Rises and Rosebud, Victoria; Montague, Tasmania. In Victoria the few records are all within the Cool Temperate Bassian.

NEMERTEA
HOPLONERTEA
PROSORHOCHMIDAE
Geonemertes Semper 1863

Geonemertes australiensis Dendy, 1892

SPECIMENS EXAMINED: Ankerhook Forest, Anglesea, Single specimen.

SPECIMENS OBSERVED: Near Cumberland River, Lorne Forest Park.

LITERATURE RECORDS: Otway Forest, Dendy (1892b).

ECOLOGY: This terrestrial nemertean was found under logs and within rotting timber in Tall Open Forest. Hickman (1963) provides an account of the ecology of the species in Tasmania, which is similar to that observed in Victoria. This nemertean was not associated with any terrestrial planarians in the Otway Region; elsewhere it has been found together with *G. adae*, *G. mediolineata*, *G. sanguinea* and *G. spenceri* in Tall Open Forest and with *G. howitti*, *G. lucasi*, *G. sanguinea* and *G. spenceri* in Alpine complex (Winsor 1973b). It is an uncommon species.

DISTRIBUTION: The distribution of the terrestrial nemertean *Geonemertes australiensis* in Australia has been recently reviewed by Moore (1975). In Victoria, the most westerly record indicated for this species was Healesville, east of Melbourne. The three records for the Otway Region extend its known most westerly occurrence in Australia; it is also recorded from the Lamington Plateau, Queensland, the Brindabellas and from Pretty Point on the Mt. Kosciusko Plateau, New South Wales, and from numerous localities in Tasmania. The distribution of this species in Victoria is mainly restricted to the Cool and Cold Temperate Bassian regions with extension into Warm Temperate Bassian in the Otways.

Specimens were identified by external characters, and distinguished from terrestrial planarians by stimulating eversion of the proboscis. Although the taxonomy of the Australian land Nemerteans is soundly based (Moore 1975), the distributions of taxa other than *Geonemertes australiensis* are poorly known, and further distributional and ecological studies are required to clarify the interrelationships between nemertean species.

The habitat types, status and Victorian zoogeographic distribution of these foregoing terrestrial planarian and nemertean taxa are presented in Table 1.

DISCUSSION

Thirty species of terrestrial planarians are known in Victoria. In this paper twelve species are recorded from the Otway Region. Eight species, including one possibly new form, are recorded in this area for the first time. The terrestrial nemertean *Geonemertes australiensis* was first recorded in the Otway Region by Dendy (1892b) and subsequently by the present author.

The habitat types and status of taxa recorded in the study area were similar to those of the same species elsewhere in Victoria, (Winsor 1973c). The majority of species were found in Open Forest, Tall Open Forest and agricultural land. Planarians were encountered only close to the periphery of conifer plantations. Simi-

lar situations have been observed in plantations in the Macedon Ranges, Victoria and near Mt. Gambier, South Australia. Overall status of species in the Otway Region showed seven common species, four uncommon species and one species considered rare.

Within the Otway Region, two zoogeographic regions are recognised: Cool Temperate Bassian which characterizes the area and a small region of Warm Temperate Bassian that impinges upon the northeastern corner of the study area. From the distribution of the taxa within the Otway Region, two species occur only in the Warm Temperate Bassian, six species occur only in the Cool Temperate Bassian and five species, including the nemertean, occur in both regions. This analysis of the taxa in the study area, with the exception of the nemertean, agrees with their distribution in Warm and Cool Temperate Bassian regions elsewhere in Victoria.

The occurrence of two typically Warm Temperate Bassian planarian species, *Geoplana munda* and *G. quinquelineata* deep within the Cool Temperate Bassian was recorded in the Otway Region. This situation has been observed elsewhere in Victoria, where both species have been recorded from cleared and agricultural lands in Cool Temperate Bassian regions. They are considered adventive species in these regions, as geographically they occur in localized, remote areas, discontinuous with the species' main areas of distribution. Collector artefact cannot account for the large gaps in distribution. Ecologically, the species are restricted to cultivated and agricultural lands, and have not been recorded from adjacent natural forest. These findings fulfil two of the five possible criteria proposed by Lindroth (1957) for the recognition of adventive species, and militate against the possibility of relict populations.

The low mobility and stenotopy exhibited by terrestrial planarians make it highly improbable that these 'anomalous' distribution patterns in Cool Temperate Bassian areas are the result of active dispersal. Biochore dispersal, particularly via domestic stock (e.g. in mud in hooves), cannot be excluded, but is considered remote. It is suggested that passive dispersal by man, via soil, vegetation, timber and masonry, all of which have been found by the author to be carriers, is the most likely explanation of these distribution patterns.

Records of terrestrial planarians considered introduced in various countries are frequently encountered in the literature. Most of these reports do not indicate whether the introduced species are endemic or non-endemic, and few indicate possible modes of dispersal. Froehlich (1955b) discussed 'man follower' species of Brazil, but did not mention likely modes of dispersal, nor whether the occurrence of endemic forms in

TABLE 1.
THE HABITAT TYPE, STATUS, AND DISTRIBUTION IN THE VICTORIAN ZOOGEOGRAPHIC REGIONS OF TERRESTRIAL PLANARIANS AND NEMERTEANS OF THE OTWAY REGION.
Negative records in this table do not imply absence of a species from a particular habitat or zoogeographic region. Status: C = Common, U = Uncommon, R = Rare. Distribution: A = Considered Adventive in this region.

TAXA	HABITAT TYPE								STATUS	VICTORIAN ZOOGEOGRAPHICAL REGION					
	OPEN FOREST	TALL OPEN FOREST	TEMPERATE RAINFOREST	SUB-ALPINE COMPLEX	COASTAL COMPLEX	WETLANDS	AGRICULTURAL LAND	URBAN		WARM TEMPERATE BASSIAN ONLY	WARM AND COOL TEMPERATE BASSIAN	COOL TEMPERATE BASSIAN ONLY	COOL AND COLD TEMPERATE BASSIAN	COLD TEMPERATE BASSIAN	EYREAN
PLATYHELMINTHES															
TRICLADIDA, TERRICOLA															
GEOPLANIDAE															
<u>Geoplana hoggi</u>	+	+	-	-	-	-	+	-	C	+	-	-	-	-	-
<u>Geoplana howitti</u>	+	+	-	+	-	-	+	-	U	-	+	-	-	-	-
<u>Geoplana mediolineata</u>	+	+	-	-	-	-	+	-	C	-	+	-	-	-	-
<u>Geoplana m'mahoni</u>	+	+	-	-	-	-	+	-	U	-	+	-	-	-	-
<u>Geoplana munda</u>	+	+	-	-	-	-	+	-	C	-	A	-	-	-	-
<u>Geoplana quadrangulata</u>	-	+	-	-	-	-	+	-	R	-	+	-	-	-	-
<u>Geoplana quinquelineata</u>	+	-	-	-	-	-	+	-	C	-	A	-	-	-	+
<u>Geoplana sanguinea</u>	+	+	+	-	-	-	+	-	C	+	-	+	-	-	A
<u>Geoplana sugdeni</u>	+	+	-	-	-	-	+	-	C	+	-	-	-	-	-
<u>Geoplana sulphurea</u>	+	+	-	-	-	-	+	-	C	+	-	-	-	-	-
<u>Geoplana sp.</u>	-	+	-	-	-	-	+	-	U	-	+	-	-	-	-
NEMERTEA															
HOPLOMERTEA, PROSORHOCHMIDAE															
<u>Geonemertes australiensis</u>	+	+	+	+	-	-	-	-	U	+	-	+	-	-	-
	10	9	2	3	1	4	10	2	-	5	4	3	-	1	1

TABLE 2.

DISTRIBUTION OF TERRESTRIAL PLANARIAN AND NEMERTEAN TAXA OF TALL OPEN FOREST AND TEMPERATE RAINFOREST, IN THE EASTERN HIGHLANDS, MACEDON RANGES, OTWAY REGION AND TASMANIA.
(A = considered adventive in the area).

Taxa	Eastern Highlands	Macedon Ranges	Otway Region	Tasmania
<u>Platyhelminthes</u>				
Geoplanidae				
<u>Artioposthia fletcheri</u>	-	+	-	-
<u>Geoplana adae</u>	+	+	-	+
<u>Geoplana caerulea</u>	+	-	-	-
<u>Geoplana dendyi</u>	+	-	-	-
<u>Geoplana dubia</u>	+	-	-	-
<u>Geoplana hoggii</u>	+	+	+	-
<u>Geoplana howitti</u>	+	-	+	-
<u>Geoplana lucasi</u>	+	-	-	-
<u>Geoplana mediolineata</u>	+	+	+	-
<u>Geoplana m'mahoni</u>	+	-	+	-
<u>Geoplana munda</u>	A	+	+	A
<u>Geoplana quadrangulata</u>	-	+	+	-
<u>Geoplana quinquelineata</u>	A	+	+	A
<u>Geoplana sanguinea</u>	+	+	+	+
<u>Geoplana spenceri</u>	+	-	-	-
<u>Geoplana sugdeni</u>	-	+	+	+
<u>Geoplana sulphurea</u>	+	-	+	-
<u>Geoplana varigata</u>	+	-	-	+
<u>Geoplana ventropunctata</u>	+	-	-	-
<u>Geoplana walhallae</u>	+	-	-	+
<u>Geoplana species</u>	-	-	+	+
Rhynchodemidae				
<u>Rhynchodemus victoriae</u>	+	-	-	-
<u>Rhynchodemus guttatus</u>	+	-	-	-
<u>Rhynchodemus simulans</u>	-	+	-	-
<u>Nemertea</u>				
Prosorhochmidae				
<u>Geonemertes australiensis</u>	+	+	+	+
	18	11	12	7

man-disturbed areas was at variance with the known distributions and habitats of the various species involved.

Knowledge of the distributions and habitats of many terrestrial planarians has been largely based on isolated records. Hitherto, no systematic distribution studies have been carried out. These present studies facilitated the recognition of adventives, particularly endemic forms, in relation to their normal distribution patterns.

The survival of these adventives in cool regions may be due to the similarity between the micro-environment of cleared land and that of Warm Temperate Bassian regions. The reduction in micro-habitat and loss of protective vegetation with increased exposure of the ground to solar radiation may favour those planarians that normally occur in warm temperate areas rather than those sensitive forms restricted to cool temperate regions. These distribution patterns and the tentative explanation for adventive survival require further investigation.

The terrestrial planarian and nemertean faunas of the Otway Region (twelve species) closely resemble those of the Macedon Ranges of Central Victoria (eleven species); eight species are shared between these regions (Table 2.) and the most significant difference between the faunas is the absence of *Rhynchodemus* (Rhynchodemidae) in the Otway Region, but present in the Macedon area. This uncommon genus has been recorded west of Warrnambool and its presence in the Otway Region is highly probable. The nemertean *Geonemertes australiensis* has been recorded by the author in the Macedon Ranges.

Of the eighteen species found in the Eastern Highlands, five are shared with the Macedon Ranges and seven with the Otway Region. Tasmania shares five species with the Eastern Highlands, four with the Macedon Ranges and four taxa with the Otway Region.

Examination of the south-eastern Australian distribution of the land planarian and nemertean taxa of the Otway Region, provides evidence on the possible origins of these faunas.

The nemertean *Geonemertes australiensis* occurs mainly in wet forest on mainland south-eastern Australia and shows disjunct distribution between the Eastern Highlands, the Macedon Ranges and its most westerly occurrence in the Otway Ranges; there is also a major disjunction across Bass Strait to Tasmania. Two terrestrial planarians, *Geoplana sanguinea* and *G. sugdeni* show major disjunctions only in their ranges to Tasmania across Bass Strait. A third species, *Geoplana sp.*, first recorded in the Otway Ranges has also been found in northern Tasmania, but its distribution is otherwise poorly known. The natural occurrence of these four taxa in Tasmania suggests that they

are Glacial relicts, having traversed the Bassian isthmus from the mainland to Tasmania during the last Ice Age. However, it is uncertain as to whether these taxa colonized the Otway Region during the last Glacial period, or whether they expanded their ranges from the Eastern Highlands region (and ?Central Victoria *G. sugdeni*) to the Otways during the Post-glacial pluvial period. The wet forest disjunctions of *Geonemertes australiensis* indicate possible expansion of range previous to more recent arid periods when the range may have contracted to present distributions.

Three land planarians, *Geoplana howitti*, *G. hoggii* and *G. sulphurea*, show disjunct distributions similar to those of *Geonemertes australiensis*, but are all absent from Tasmania. It is suggested that these taxa are Post-glacial intrusives that probably expanded their ranges in the Post-glacial pluvial period, perhaps accompanying the spread and development of Post-glacial forests. The subsequent arid period resulted in the contraction of their ranges giving rise to present distribution patterns.

The distributions of the foregoing taxa, considered Glacial relicts and Post-glacial intrusives, are very close to those of reptiles (group c) considered Glacial relicts, and those (group b) reptiles considered Post-glacial intrusives by Rawlinson (1974).

Two species, *Geoplana munda* and *G. quinquelineata* show fairly continuous south-west to north-east distribution (apart from isolates considered adventives, as previously discussed) through Central Victoria, extending into South Australia and New South Wales. These distributions in the drier regions of south-eastern Australia, and the absence of natural populations in wet forests of Victoria and Tasmania suggest recent speciation, possibly in response to the Post-glacial arid period environment. The peripheral natural occurrence of these two taxa in the Otway Region may indicate recent expansion of their ranges, utilizing the dry forest and plain habitats.

There is insufficient distribution data for *Geoplana m'ahoni* and *G. quadrangulata* to allow discussion of their origins. *Geoplana mediolineata* appears to have close affinities with three West Australian and South Australian taxa, and the distribution of this species is thus confused. The origin and affinities of *G. mediolineata* can only be discussed when its relationships with the other similar taxa are clarified.

From the foregoing discussion, the land planarian and nemertean faunas of the Cool Temperate Bassian regions to the west of Melbourne (Otway and Macedon areas), compared to those east of Melbourne, differ significantly by the absence of some typical Eastern Highland wet forest forms. In particular, the common and widespread blue-green species, *Geoplana caerulea*, *G. dendyi* and *G. spenceri* have not been

recorded west of Mt. Disappointment, Victoria, nor in Tasmania, although suitable wet forest habitats occur in these regions.

Recent evidence indicates that the present Otway vegetation is Post-glacial in origin, and that there has been no continuity of habitat between the Eastern Highlands and the Otway Region (Rawlinson, unpublished). This discontinuous forest habitat probably acted as a filter, possibly limiting strictly wet forest forms, such as the blue-green land planarians of the Eastern Highlands, to continuous wet forest habitat. However, species able to survive in and colonize habitats other than those of wet forests were able to radiate to the Otway Region. Differences between the terrestrial planarian and nemertean faunas of the Macedon Ranges and the Otway Region may reflect more favourable habitat between the Otways and the Eastern Highlands than between the latter area and the Macedon Ranges.

This discussion of the origins and affinities of the land planarians and nemertean faunas of the Otway Region has been primarily based upon distributional and ecological data. The phylogenetic relationships between the various terrestrial planarian taxa are poorly understood due to inadequacies in the present taxonomy of the group.

ACKNOWLEDGMENTS

The author is indebted to Dr. Brian Smith of the National Museum of Victoria for kindly providing access to specimens and records under his care, and particularly for his support and encouragement. Dr. Ray Gibson of Liverpool Polytechnic read and criticized the manuscript; Dr. Pat. Hutchings of the Australian Museum gave access to specimens and records under her care; Chris Dally typed the manuscript. To all of these the author is grateful. He wishes also to thank members of the FNCV Field Survey Group and Hawthorn Junior Field Naturalists Club for help in collecting specimens. Finally, he wishes to thank his wife, Heather, for her willing assistance and constructive criticisms of so many aspects of this continuing study.

REFERENCES

- BROOK, A., 1975. The distribution of Anuran Amphibians in Victoria. *Vict. Nat.* 92: 104-120.
- COLE, L. C., 1946. A study of the Cryptozoa of an Illinois Woodland. *Ecol. Monogr.* 16: 49-86.
- DAVIDSON, J., 1954. Bioclimatic Zones of Australia. In: Andrewartha, H. G. & Birch, L. C., *The Distribution and abundance of animals*. University of Chicago Press.
- DENDY, A., 1891. On the Victorian Land Planarians. *Trans. R. Soc. Vict.* 2: 65-80.
- , 1892a. Additional observations on the Victorian Land Planarians. *Ibid.* 2: 25-41.
- , 1892b. On the Australian Land Nemertine (*Geonemertes australiensis*, n. sp.). *Proc. R. Soc. Vict.* 4: 85-112.
- , 1895. The Cryptozoic Fauna of Australasia. *Rep. Australas. Ass. Advmt. Sci.* 6: 99-119.
- FROELICH, C. G., 1955a. Sobre morfologia e taxonomia das Goplanidae. *Bol. Fac. Fil. Cien. Letr., Zool.* 19: 195-279.
- , 1955b. On the biology of land planarians. *Ibid.* 20: 263-272.
- GENTILLI, J., 1972. *Australian Climate Patterns*. Thomas Nelson (Australia) Ltd.
- GIBSON, R., 1972. *Nemerteans*. Hutchinson and Co. Ltd., London.
- GRAFF, L. VON., 1899. *Monographie der Turbellarien II. Tricladida Terricola*, Endemann, Leipzig.
- HICKMAN, V. V., 1963. The occurrence in Tasmania of the land nemertine, *Geonemertes australiensis* Dendy, with some account of its distribution, habits, variations and development. *Pap. Proc. R. Soc. Tasm.*, 97: 63-75.
- LINDROTH, C. H., 1957. *The faunal connections between Europe and America*, Almqvist and Wiksell/Gebbers. Stockholm; and Wiley, New York.
- , In M.D.F. Udvardy, 1969. *Dynamic Zoogeography with special reference to land animals*. Van Nostrand Reinhold Co., New York. p.344 (not sighted)
- MOORE, J., 1975. Land Nemertines of Australia. *Zool. J. Linn. Soc.*, 56: 23-43.
- RAWLINSON, P. A., 1969. The Reptiles of East Gippsland. *Proc. R. Soc. Vict.* 82: 113-118.
- , 1971. Reptiles of Victoria.
- , 1974. Biogeography and Ecology of the Reptiles of Tasmania and the Bass Strait Area. in: W. D. Williams (ed.) *Biogeography and Ecology in Tasmania*. Junk, The Hague.
- SERVENTY, D. L. & WHITTELL, H. M., 1951. *Handbook of Birds of Western Australia*. Paterson Brokensha, Perth. pp. 44-48.
- SMITH, B. J., & LONG, D. C., 1970. Plans for a proposed census of Non-Marine Molluses in Victoria. *Vict. Nat.* 87: 169-170.
- SPRECHT, R. L., 1970. Vegetation. In: G. W. Leeper (ed.). *The Australian Environment*. CSIRO & Melbourne University Press.
- WINSOR, L., 1973a. *Geoplana atrata* Steel, 1897 — A new land planarian record for Victoria. *Vict. Nat.* 90: 101-102.
- , 1973b. *Geoplana varigata* Fletcher and Hamilton, 1887 — A new land planarian record for Victoria. *Ibid.* 90: 264-265.
- , 1973c. Land Planarians. In: *Land Conservation Council, Victoria, Report on the Melbourne Study Area*. Government Printer, Melbourne.